CHAPTER 10

Needed Now:
The "85% Quick Fix" in Bio-Defense

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Introduction

Some new proposals are presented to provide an "85% Quick Fix," including implementation of a Bio-Threatcon level, building preparation, providing off the shelf 1/2 mask respirators and more.

The search for the "best solution" for bio-defense is proving to be an obstacle to finding the more immediate "good solution." In the day when Americans have grown used to fast food, instant access to the Internet, and minimal United States' casualties during war, many have come to expect a "silver bullet solution" for almost any problem. The military, like the rest of America, is often in quest for the 100% solution to its challenges. For example, the military, now awakened to the biological warfare/biological terrorism (BW/BT) threat, is in search of the perfect solution to the problem posed by biological weapons. The pursuit of the 100% solution often diverts efforts from potential quick (though incomplete) fixes for such tough problems that could provide valuable protection. Some new proposals are presented to provide an "85% Quick Fix,"[1] including implementation of a Bio-Threatcon level, building preparation, providing off the shelf 1/2 mask respirators and more. While the technical information in this paper needs further study, it is hoped this chapter will provoke discussion and stimulate the development of new ideas for immediate solutions (albeit partial solutions) rather than waiting on the 100% solution.

In April 1990, two U.S. naval bases, Yokosuka and Yokohama, were attacked with botulinum toxin, and although they failed, the scenario could have turned out much different. A home-grown Japanese terrorist organization, Aum Shinrikyo, had amassed over a billion dollars in net worth and had developed a clandestine biological warfare program. This group became famous for its nerve agent attack in the Tokyo subways in March 1995 that killed 12 and injured 5,500. Fortunately, in 1990, technology and scientific know-how were not as accessible as they are today, and as a result, the Aum Shinrikyo cult had not perfected its program.[2] To our knowledge, no U.S. forces became ill from this attack. But if this attack occurred today when technological capabilities and the proliferation of information are rampant, it seems far more likely they would have been successful, leading to thousands of U.S. forces casualties.

Likewise, consider the Gulf War in 1991 when the U.S. had 320,000 military personnel massed in a 50 by 150 mile rectangular area southeast of Iraq. The Office of the Secretary of Defense estimated if an anthrax attack had occurred on our troops, 76,300 individuals would have died if they were not vaccinated. On the other hand, if all were vaccinated, it was estimated that only 122 would have died. Conversely, what if the attack had been tularemia, Q-fever, or a host of other biological agents for which we do not have a vaccine? Thousands would have died or become ill because we did not have even a partial protection from such agents. Yet, if an "85% Quick Fix" was put into place, hundreds or possibly thousands of lives could be saved, allowing the military mission to continue.

Since there is no mechanism in place today to provide even partial protection from a biological warfare attack at most military installations, both the Aum Shinrikyo and the Gulf War scenarios have grave implications. U.S. military forces could suffer death tolls higher than the tragic events of September 11, 2001, unless some interim efforts for partial protection occur prior to finding the 100% solution. With the "85% Quick Fix," it is hypothesized 85% of the affected soldiers would be protected.

Indeed, there is an obligation to protect our forces completely from threats when practical. We owe that protection to U.S. military personnel, to their families, and to our nation. Yet, the complexities of this threat

make it difficult to field comprehensive defensive measures in the near-term — and BW/BT threats exist today. The weapons of this threat are bacteria, viruses, other microorganisms, and toxins. Unlike TNT, chemicals, and radioactive material, biological organisms are alive and can adapt to new challenges in the quest for survival. These invisible weapons are much different from other threats. They can be released to travel difficult terrain silently and effortlessly over long distances, creating sickness and death in their wake.

Sometime in the 21st century we may be able to provide 100% protection against all the dozens of pathogens that might be used as weapons. However, unless we adopt a group of partial fixes now, our military forces will be left grossly vulnerable to the BW/BT threat while we search for a more comprehensive breakthrough in vaccines, sensors, and other counters. We have much ground to make up in biodefense. Until very recently, senior DoD leaders were unable to grasp the urgency in protecting military forces and were unwilling to obligate large investments necessary to counter an unlikely event. Hopefully that has changed.

The anthrax attacks in the United States during the Fall of 2001 have helped convert many such doubters, but further complicating a solution is the fact that some within DoD have seen this problem as "too hard to do." Not knowing just what to do and not sure the threat was real, they did little. Also, one of the difficulties in preparing for this threat is the military's fixation on technological answers more than procedural solutions. That finally may be changing, because a few in the military are beginning to ask, "Is there an inexpensive, quick fix that can provide partial protection for our forces while we look for the 100% solution?"[3] Our frustrating quest for such items like the "detect to protect"[4] technology provided by biological detectors or highly reliable vaccines for a myriad of pathogens has led many to despair. Others have realized that for immediate protection, new technology innovations may not be the major portion of the immediate solution.

Today, more than a dozen countries are suspected of having some level of a biological warfare program. It is also true that terrorist organizations such as Al-Qaeda have shown a keen interest in obtaining these weapons. Since Al-Qaeda says it is their God-ordained

responsibility to kill Americans and most of the countries with BW/BT programs are not our best of friends, it is important we get to the immediate business of what might be termed the "85% Quick Fix"– some simple, effective, and immediate counters to today's biological weapons threat. Effective interim and partial protection might be accomplished with several simple procedural changes and by minor applications of current technology at modest expense.

The quest for the perfect answer can be the enemy of the "good solution," and no one would credibly argue that 100% of personnel left unprotected in the near term is better than protecting 85% of personnel immediately through quick-fix procedures.

Defining the BW/BT Threat

The biological threat can be quantified by integrating three distinct variables:[5]

- An adversary's *intent* to use biological weapons
- An adversary's *capability* to use biological weapons
- Our own *vulnerability* to biological weapons

Enemy *Intent* + Enemy *Capability* + U.S./Allied *Vulnerability* = Threat

It is beyond the scope of this chapter to thoroughly analyze the possible intent of various rogue states/adversaries or to fully describe the myriad of biological weapon agents that may be used in an attack. Likewise, it is important to understand that to appropriately defeat BW/BT a full range of activities should be pursued, including: arms control, export controls, diplomatic and economic sanctions, deterrence, counterforce, active defense, passive defense and consequence management. However, this analysis will look at how a few simple and immediate steps can be taken to mitigate the hazards from biological weapons in the areas of passive defense, intelligence and warning, consequence management, and active defense/offensive options.

Understanding BW Agents

Threats like biological warfare/biological terrorism can be serious when the United States and/or its allies are vulnerable, and this is generally the case for every BW agent. This vulnerability is in turn a function of the characteristics of the BW agents and their various delivery systems. Nevertheless, the details of U.S. vulnerability are critical to determining the potential impacts of a BW attack.

Many sources suggest that BW threats can be overwhelming. The actual area in which people would be affected by BW would vary depending upon the means of delivery (aerosol delivery is generally expected to be the most serious),[6] the quantity and positioning of the BW source, time of day, weather conditions, where people are located, what they are doing when exposed, and various other factors. For example, the Congressional Office of Technology Assessment indicated that 100 kilograms of anthrax could cover 46 to 300 square kilometers with lethal effects, depending upon weather conditions,[7] while other sources suggest potentially larger areas.[8] Another source suggests that spray from "… a single airplane could be expected to infect a high percentage of individuals within an area of at least 10,000 km^2" with equine encephalitis (VEE, EEE, or WEE).[9] These large areas suggest that even Special Forces carrying a kilogram or so of BW, could affect large parts of a city, airfield, port, ground force base, or command/control or logistics facility. An aircraft or missile carrying tens of kilograms of BW agents could thoroughly overwhelm most military targets and cover much of the surrounding areas.

There are a significant number of biological agents that have different characteristics, as shown in Table 1. These weapons vary in their potency (ECt_{50}),[10] their lethality, their survivability in air and other media, their period of incubation and duration of effects, whether they are contagious between people, the degree to which they can be prevented (e.g., by vaccines) or treated (e.g., by antibiotics), and their potential resistance to various forms of treatment (e.g., in antibiotic resistance). For example, a toxin like Staphylococcal Enterotoxin B (SEB) could rapidly affect a military population (starting within 2 hours or so), would have serious effects for perhaps a day or so, have residual effects for as long as weeks, should cause few fatalities, and could be treated only by supportive treatment. Alternatively, some bacterial weapons like anthrax and plague

take longer to incubate, are highly lethal, but can generally be countered by certain antibiotics if these are taken in a timely manner and the BW agent has not been engineered to resist the antibiotic.

Table 1

Characteristics of Some BW Agents

Agent	ECt_{50}* (µg)-min/m^3	Nighttime Decay (%/min)	Untreated Mortality(%)	Incubation (Days)	Contagious	Treatment	Vacc.
Bacteria							
Anthrax	0.01	0-0.1	100	1-6	No	Antibiotic	Yes
Plague	0.01	10	100	2-3	Yes	Antibiotic	No**
Tularemia	0.0001	5	5-60	2-10	No	Antibiotic	IND
Q Fever	0.00002	0-0.1	0-1	10-40	Rare	Antibiotic	IND
Toxins							
Bot Tox	0.1	5	5	1-5	No	Antitoxin*	IND
Ricin	200*	?	High*	18-24 hr*	No*	Support*	No*
SEB	0.03*	1	1	3-12 hr	No	Support*	No
Viruses							
VEE	?	?	Low*	2-6*	Low*	Support*	IND*
Ebola	?	?	50-90*	4-21*	Moderate*	Support*	No*
Smallpox	0.1	0.5	15-40	7-17	Yes	Support*	Yes

* ECt_{50} - Exposure Concentration Time 50%; Vacc. – Vaccine; SEB-Staphylococcal Enterotoxin B; VEE - Venezuelan Equine Encephalitis; IND – Investigational New Drug

Source: Brian G. Chow, et. al., *Air Force Operations in a Chemical and Biological Environment*, RAND, DB-189/1-AF. 1998, 29. Values with a "*" come from USAMRIID, *Medical Management of Biological Casualties Handbook*, February 2001, 64 and Appendices C, D, and I. The vaccine for plague "**" (actually for bubonic as opposed to pneumonic plague) is no longer being produced per Thomas V. Inglesby, et. al., "Plague as a Biological Weapon," *JAMA*, May 3, 2000, 2285.[11]

The impact of the different potency and decay rate values is illustrated in Figure 1, based on a series of biological weapons exposure curves produced by the Hazard Prediction and Assessment Capability (HPAC) model for a one-kilogram BW agent release of one-kilometer width. The model also assumes a temperature inversion and a wind speed of approximately 10 mph. Even in daylight (8:00 a.m.), the model shows that the concentration of viable anthrax stays above the median infective dose for an hour or so after the release (reflecting its relative resistance to

UV degradation). This is enough time to cover most fixed military targets as long as there is a temperature inversion, the wind was properly forecast, and the original release was sufficiently wide. At night (8:00 p.m.), the anthrax concentration stays above the median infective dose for several hours, sufficient to cover large military assembly areas with a favorable breeze. In contrast, the greater potency (determined by the reduced number of microorganisms required to induce infection) of tularemia starts with far higher infective dose levels, but the infective dose declines much more rapidly because of the decay rate of tularemia in air. Still, the dosage for tularemia is well above the median infective dose for almost two hours, giving reasonable time to cover most fixed targets. Indeed, even modest amounts (a kilogram or so) of both anthrax and tularemia should carry well beyond an intended military target and could affect large civilian areas under ideal conditions. With anthrax, doses well less than the median infective dose may still cause some lethal exposures many hours after the release, well downwind of the target.[12]

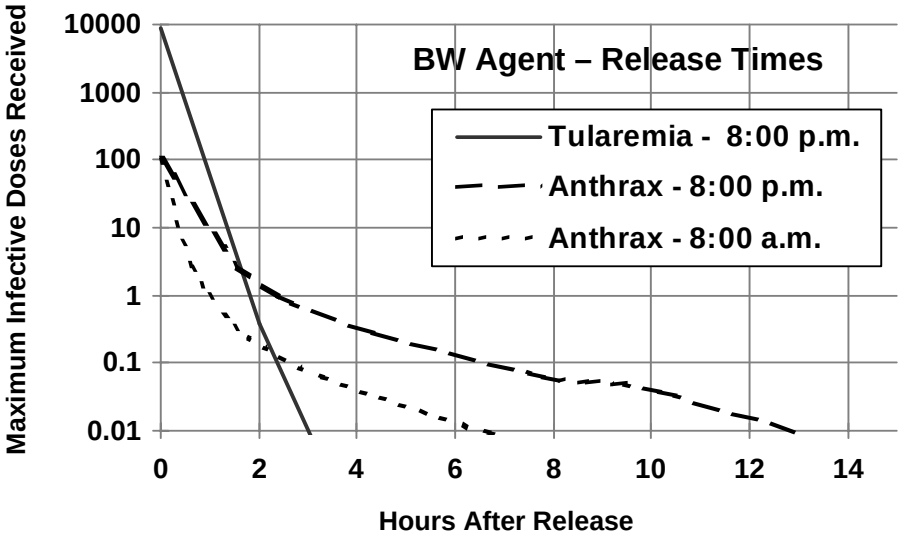

Figure 1 - Maximum Infective Dose Received at the Front of a BW Cloud traveling at approximately 10 mph.

(Decreased dose over time is primarily due to degradation from ultraviolet light and dispersion of the agent in the air. This figure is based on a one kilogram released over a distance of one kilometer.)[13]

Antibiotics against bacterial weapons can often be effective, whether used for treatment[14] or for post-exposure prophylaxis.[15] Nevertheless, use of antibiotics could still lead to some debilitating side effects[16] that could impact both civilian and military operations. While antibiotics fight bacteria, many toxins and viruses lack a direct means of treatment (as shown in Table 1), meaning that victims will be sick and many will be incapacitated for some period of time.

The Soviets, recognizing the potential for antibiotics to defeat many biological agents, developed genetic variations of BW agents (such as plague, anthrax, and tularemia), that were resistant to various antibiotics. One of the Soviets' former leading bio-weaponeers stated:

> "There was a task force to develop a new strain of weapon with a resistance to ten antibiotics. These antibiotics were first released in the United States and some European countries just to treat infections. In 1989 it was very difficult to have strains of plague resistant to antibiotics. But one of our facilities developed a new approach. They developed two different strains resistant to five antibiotics each. And they cultivated them together and they have a mutual relationship, one with another. That was about ten, twelve, fifteen years ago. Recently, Russian scientists have proclaimed success in developing a *Bacillus anthracis* strain resistant to most antibiotics."[17]

Mitigating U.S./Allied Vulnerability Against Bio-Weapons

The U.S. military has studied the BW threat and concluded that the military's goal of full-dimensional protection, enshrined in *Joint Vision 2020*,[18] cannot be achieved against BW today (no 100% solution). Each element of a potential response to BW use is limited in its ability to resolve the threat. Therefore, no individual element can mitigate the BW threat. Yet, the "85% Quick Fix" could be realized if the following four areas are addressed: passive defense, intelligence and warning, consequence management, and active defense/offensive options.

Passive Defense Quick Fixes

Passive defenses seek to prevent the infection of people by a BW attack. Passive defenses include several elements:

Vaccines - A vaccine is an antigen that is introduced into the body to stimulate the immune system to build defenses against that antigen. An effective vaccine will neutralize a specific virus, bacteria, toxin, or rickettsiae - the four categories of BW agents. In the future it is hoped one vaccine will be developed that boosts the immune system against all or many diseases. But for now, vaccines are disease-specific. Relatively few vaccines are FDA approved for use against BW agents, and all of those, specifically the anthrax and smallpox vaccines, are controversial. Nevertheless, vaccines are one of the most effective ways to reduce BW vulnerability, especially against the most serious BW agents like anthrax and smallpox. This is probably the greatest payoff area for protecting military forces long term and DoD should fund this at much higher levels.

Individual protective equipment (IPE) - includes various kinds of masks and suits; it keeps BW agents away from people and thereby prevents infection. The quandary with IPE is that its use reduces operational effectiveness, and in many weather conditions, it can only be used for a limited period of time (it causes heat casualties and other effects after a period of minutes to hours). The most devastating BW threats come from aerosol delivery; a commercial half mask respirator will significantly reduce biological agent inhalation providing protection factors of 50 to 500 or more against BW stimulants—a level of protection often adequate to prevent infection, without the operational degradation and heat burden of traditional chemical masks.[19]

Collective protection systems (CPS) - are facilities that provide a BW-free area by filtering incoming air. These are places where people can eat and sleep, change clothes, and perform other operations without being vulnerable to BW agents or having to wear the hot and cumbersome protective boots, gloves, masks and over garments. Many facilities could provide much protection from BW agents, albeit not 100% protection, with minimal upgrades as outlined later.

Biological decontamination - includes solutions and delivery devices to neutralize BW agents in the air, ground, water, or on people or their

clothing. Advances are being made technologically in this field and will help us move toward the 100% solution.

Avoidance and Operations - With chemical weapons, rapid detection of an attack allows commanders to direct personnel to avoid exposure, for example by moving in-doors and turning off heating, ventilation, and air conditioning (HVAC) systems that would otherwise draw the agent into the building. Because biological weapon detection is so slow, such procedures generally will not be implemented quickly enough after detection to help; indeed, by the time BW detection occurs, the air outside will likely be clear of contamination while the air inside buildings may be contaminated because of HVAC operations.[20] Therefore, if the HVAC was shut off shortly after an attack the levels of BW agent might linger in a building long after the outside air has cleared.

Dissimilarly, the sensitivity and rapid response of chemical detectors allows users to fairly quickly identify the area of contamination and mark it so that people can be directed to stay out. But with BW, most detectors, due to sensitivity and specificity shortfalls, may not identify some contaminated areas and may not be sufficiently sensitive to identify some potentially infectious dosages. As a result, an extremely conservative view is often taken whereby detection of any BW agent usually becomes the basis for complete isolation of that and surrounding areas; this will probably help people to avoid contamination but often restricts the use of more areas than necessary, while missing some areas that may be contaminated.

One concept of military operations when potentially facing chemical or biological weapon threats is similar to the concept when facing nuclear threats: forces should disperse to operate at low density to reduce the damage that can be done by any given attack. Currently most concepts of operations are designed to build tent cities that force all the personnel in a small area. It is not clear, however, that military units are prepared to execute dispersion of personnel on a base. While this would be beneficial for a point release close to the base, this concept would not be as helpful for a line source release that would disperse BW agent over a large area. Nevertheless, an effort to disperse people on a base if there is a potential BW attack might lessen the likelihood of some individuals being exposed once an attack occurs.

Operational procedures can also help when combined with knowledge of the limits of various biological weapons. Most biological agents degrade rapidly with ultraviolet (UV) light. For instance, *Francisella tularensis* dies at a rate of 50% every 20 minutes on a bright sunny day. There are only two biological agents that are generally considered "UV resistant" and those are *Bacillus anthracis* (anthrax) and *Coxiella burnetii* (Q Fever). Even though their degradation is refractory to UV light, they still decay at a rate of approximately or less than 0.1% per minute in sunlight.[21] Based on this understanding, it is far more productive and, therefore, likely for an adversary who wants mass casualties to launch a BW/BT attack when there is no sunlight, since such an attack has a much greater potential for delivering higher concentrations of virulent organisms.

Although biological agents can be delivered by several mechanisms, biological agents that are aerosolized would be dependent on the wind to move them. If it is a day with less than 3 mph of wind and an attacker is outside the fence of a military installation spraying a biological agent, the germ cloud will not move very far and probably will not pose a major threat to personnel on base. Conversely, if the wind is too strong, perhaps at speeds greater than 23 to 25 mph, the cloud of agent is thought to become so unstable and diffuse so rapidly that it is unlikely to deliver enough concentration to infect many individuals and cause a mass casualty event. Of course, distance from the point of dissemination is also important here. If an individual or group was very close to the release point, whether there was slow or fast wind speeds, concentrations may still be high enough to infect large numbers of people.[22]

In order for a biological weapons attack to be optimally successful, the wind needs to be blowing at certain velocities and no UV light should be present. Additionally, biological agents will not infect anyone unless they are close to the ground in the human breathing zone, 3 to 7 feet above the surface. This means a temperature inversion would be necessary to keep large concentrations of the BW agent close to the ground. Temperature inversions, where cold air overlays and pins warmer air against the ground, may occur at various times of the day but usually occur at dawn, dusk, or night. Also, certain seasons of the year are more likely to have temperature inversions than others, helping forecasters to predict their occurrence. Additionally, it may seem counterintuitive, but Bill Patrick, an expert in offensive biological warfare, has stated that light

to moderate rain or snow will not appreciably affect the delivery of aerosolized BW agents. In other words, light to moderate rainstorms do not wash the skies clean of BW particles.[23]

Building Preparation Before the Attack - All buildings, including homes, where persons might be present during dawn, dusk or night should be inspected and made as airtight as possible. Simple efforts such as caulking, painting, taping, or sealing around doors or windows might greatly reduce the airflow through a building.[24]

Inexpensive small particle air filters are now available at hardware stores that can be installed in most existing air conditioning or heating units. This is not as good as creating positive pressure throughout a building to keep air flowing into it, nor does it provide as good a filtration as provided by a High Efficiency Particulate (HEPA) filter, but it is something that can be done now with minimal expense.

Although there are many manufacturers of these types of filters, here are two examples of filters that can be purchased at local hardware stores. Web Products from Kansas City, Kansas has a filter called *The Web Plus* that is marketed as "trapping 91% of the pollen, dust, and dander sized particles from 0.245 to 85 microns" and the fourteen by twenty inch version was priced at $8.40 per filter.

3M Construction and Home Improvement Markets Division from St. Paul, Minnesota has a filter called *Filtrete: Ultra Allergen filter* that is marketed as "90% effective at capturing large allergens like mold spores and pet dander … captures bacteria and particles that can carry viruses" and in calling their toll free number, one of the authors was told that it is "90% efficient at removing particles from 0.1 to 10 microns." The 3M filter was $15.97 per filter for the sixteen by twenty inch size. The idea of using these higher efficiency filters is to get a quick improvement in filtering BW/BT agents without requiring new blowers or other expensive, time consuming modifications to be made to existing ventilation systems.

Since buildings with larger concentrations of people might elevate the risk of mass casualties if they became contaminated, some extra precautions might be reasonable for them. Buildings that would likely house over, perhaps, 50 people at dawn, dusk, or night could be equipped with counter-bactericidal UV lights in the ventilation systems. Rather than turning them on during higher Bio-Threatcon levels, it would probably be easiest to have them lit whenever the ventilation system is running. The lights would need

to be arranged in ventilation ducts to provide maximum contact with BW agents. Although these may not affect *Bacillus anthracis*, *Coxiella burnetii*, or smallpox appreciably, the lights, if properly arranged, would likely have significant effect on many other bacterial agents.

Stand-alone room filtering devices are now available as commercial off-the-shelf items. These small freestanding units re-circulate the air in rooms through the unit's filter thereby trapping particles. If biological agents get into the building, these devices might greatly reduce the level of concentrations that people would breathe. This would be effective as long as the filter captured particle sizes in the 1 to 10 micron diameter range, the size that tends to lodge in the lungs of those exposed. A side benefit filters like this might offer is that if a BW attack did occur they could be sent to a diagnostic lab for confirmation of the particular agent that had been in the air.

Intelligence and Warning

The greatest problem in defending against BW attacks is the limited amount of intelligence and warning we will likely have. In contrast to chemical weapon attacks, where there are a multitude of detectors that can provide tactical warning of attacks, there are BW detectors at very few bases today (though the number of bases is expanding), and in general, they take too long to provide adequate attack warning.

For example, the Portal Shield system deployed at a number of U.S. military bases takes roughly half an hour to process an air sample and determine that it potentially contains a BW threat. By that time, an aerosolized BW cloud has usually passed through a military base being attacked, exposing almost everyone before protection can be applied in response to warning. This type of warning is usually referred to as "detect to treat" rather than "detect to protect," the preferred approach. Detect to treat allows the base to promptly begin treatment for BW exposure, which could significantly reduce or eliminate casualties in the case of most bacterial and some other biological weapons.

A preferred solution for warning would involve rapid standoff detection: the ability to see BW agents in an approaching cloud and quickly identify them. If this can be achieved, then personnel would have time to don protective clothing or move into protected buildings before arrival of a BW cloud, and thereby, not be infected. Work is ongoing to

develop such detectors, but they appear to be still several years away from production and deployment.

In places where there are no BW detectors or as a back-up to BW detectors, discovery of a BW attack can be achieved by disease surveillance at hospitals and other medical facilities. Recognition of a BW attack may not happen until symptoms develop, which, according to the incubation periods in Table 1, will normally be days after the attack. Still, aggressive disease surveillance is an important part of the "85% Quick Fix" and should receive major attention and resourcing at installations.

However, when the initial detection of a BW attack has happened, it is then necessary to confirm that the suspected biological agent is indeed what it appears to be, and also to determine if it has been mixed with other biological agents (especially contagious ones) which have not yet been detected. This process is pursued through advanced medical laboratory capabilities. Once such a confirmation is accomplished, medical officers have a stronger basis for taking actions to treat for the identified BW agent.

While the military has labs capable of such confirmation in a few locations overseas, it needs to deploy more labs and enhance the capabilities of these facilities (giving them the ability to identify more types of BW agents)—an important part of the "85% Quick Fix." Although each year technology greatly improves the ability to detect and identify particular BW agents, appropriate resourcing with today's technology would provide a large and immediate improvement. The ongoing cost will be that the Department of Defense will need to be willing to switch out old systems as new technologies for bio-detection are developed, much like it does as it continually updates its computer and software systems.

Bio-Threatcon Levels - To reduce U.S. forces, Allied Forces, and civilian *vulnerability* to BW/BT attacks, military installations should develop and issue warnings of the daily Bio-Threat condition (Bio-Threatcon) level**,** reflecting the likelihood of a successful aerosol BW attack that could inflict massive numbers of casualties. Then decision guidelines can be established to help commanders make reasonable and logical force protection decisions.

The Bio-Threatcon level would be determined by two pieces of information – the first, "BW/BT Intel Threat (BIT)" levels, is designed to

help predict the likelihood of a BW attack. The intelligence officer at each installation could fuse at least four and perhaps more types of information to assign a BIT level: (1) the current overall force protection level (alpha, bravo, charlie, delta), (2) current intelligence assessments of the BW/BT *capability* of an adversary, (3) assessments of the predicted *intent* of the adversary, and (4) assessments of adversary movement of SOF or activity with other potential BW delivery systems.

This data, some objective and some subjective, would be amalgamated to come up with a BIT level (ranging from 1 to 4). "One" would indicate that an adversary is very unlikely to use BW on the given military installation, whereas, "Four" would indicate a BW attack was very likely. Two and three would be interim ranges between one and four.

The BIT level would be integrated with another variable, the "Bio-Attack Climatology Effectiveness" (BACE) level, which would be made up of meteorological factors such as wind speed, ultraviolet light levels, and the probability of a temperature inversion. A meteorological computer model could be developed without great difficulty to integrate these three variables, as a minimum, giving current and projected BACE levels that would predict the likelihood of specific meteorological conditions for successfully delivering enough biological agents to cover an airfield or other military facility to cause mass causalities. Note, though, that depending upon the size of the target to be affected and other factors, a successful BW attack might still be carried out in conditions that are not climatologically ideal.

The BACE levels would be assigned so that BACE-1 means the climatogical conditions are extremely adverse toward a successful biological attack, whereas a BACE-4 rating would indicate the existence of optimal climatic conditions for a successful enemy biological attack.

For BIT level 2 and above (heightened likelihood of an attack), the BACE computer model should be run continuously. At these heightened threat levels the "Bio-Attack Climatology Effectiveness" levels should be available instantly to the Intelligence Officer and the Command Staff because BACE is meaningless unless it is combined with the "BW/BT Intelligence Threat" level. At the BIT level 1, "Bio-Attack Climatology Effectiveness" levels would only be calculated intermittently to indicate the conditions that would be climatologically ideal for a mass casualty attack using a BW agent.

After the "BW/BT Intel Threat"(BIT) level and "Bio-Attack Climatology Effectiveness"(BACE) levels are determined, it would be easy for a commander to see where their axes intersect and determine an overall Bio-Threatcon level (**BIT + BACE = Bio-Threatcon Level**). This intersection would be assigned a designator of alpha, bravo, charlie, or delta. Similar to other threatcon levels that the military are accustomed to, the alpha is the lower threat level while the delta is the highest threat level. The model (Table 2) shows alpha where the threat is so low that a commander would not need to implement protection procedures. But a delta would mean the highest level of threat for a successful biological attack that might cause mass casualties has been achieved, and all personnel on the installation are at great risk. Obviously, bravo and charlie are in between areas where there is a heightened threat of exposure but are less likely than delta.

A notification system for base personnel at military facilities also would need to be designed. Some options available are the installation "Giant Voice," audio and visual alarms, individually carried beepers, and/or television broadcast warnings. Base personnel should exercise these notification procedures during dawn/dusk hours or the times a given base is most likely to be vulnerable. The entire base populace, even civilians and dependents, will need to become familiar with these procedures because any large number of people that become casualties would affect the mission regardless of who they are.

Currently, most installation meteorologists, bioenvironmental engineers, epidemiologists and intelligence officers at the installation level do not have adequate training in biological warfare issues. To properly manage the Bio-Threatcon levels and be a valuable consultant to the commander, these individuals would require scientific training dealing with aerodynamics of BW agents, signatures of BW facilities, etc.

The idea of including a biological warfare threatcon level into the more well known "Force Protection Condition Level" (FPCON) is attractive to help simplify the number of indices a commander would have to keep track of to protect his forces, but it would undermine the awareness needed. Just as there is an "Information Threat Condition Level" (INFOCON) that is distinct from FPCON, Bio-Threatcon levels should also be distinct.[25]

Several unique aspects of BW/BT make it appropriate that the Bio-Threatcon level be separate from FPCON. Some examples of these unique aspects include: (1) silent weapons that can be delivered many miles from the base, (2) some adversaries are known to already possess BW/BT capability, (3) some adversaries are thought to be very unlikely to use BW/BT, (4) the intent of certain adversaries may be clearly toward civilian rather than military targets, (5) detection of an ongoing attack is not very likely because of the level of sophistication of today's detection systems, or, (6) unlike conventional weapons, aerosol delivered biological weapons can be greatly affected by meteorology.

Table 2

Commander's Decision Matrix to Avoid Mass BW/BT Casualties
Bio-Threatcon Levels[26]

BIT-4: Attack most likely)	BIT-4	*Bravo*	*Charlie*	*Delta*	*Delta*
	BIT-3	*Alpha*	*Bravo*	*Charlie*	*Charlie*
	BIT-2	*Alpha*	*Bravo*	*Bravo*	*Bravo*
BIT-1: Attack least likely)	BIT-1	*Alpha*	*Alpha*	*Alpha*	*Alpha*
BW/BT Intel Threat (BIT) level		BACE-1	BACE-2	BACE-3	BACE-4
		(Low effectiveness)			*(High effectiveness)*
(BIT level is derived from at least four components of information) 1. FPCON level 2. Capability of adversary 3. Intent of adversary 4. Adversary's movement of BW/BT delivery systems		**Bio-Attack Climatology Effectiveness (BACE)** *(UV light, Wind Speed, Probability of Temperature Inversion)*			

Bio-Threatcon Levels:	*Alpha* = Minimal Threat	*Charlie* = Partially Effective BW/BT attack possible with elevated risk
	Bravo = Partially Effective BW/BT attack is possible	*Delta* = Effective BW/BT attack is likely

Below are some thoughts on how a commander could respond at the different Bio-Threatcon Levels:

1. A (*Alpha*) - No precautions needed.

2. B (*Bravo*) -

   - All outside personnel on duty must wear lightweight half mask[27] respirators that cover nose and mouth, which can be purchased inexpensively using commercial off the shelf (COTS) technology.
   - All other personnel are encouraged to stay indoors or, if they must go outside, to wear the half mask respirator.
   - Outside personnel are educated to stand with their back to the wind as much as is possible when outside as long as it does not affect completion of the mission.[28]
   - Building ventilation systems should be turned off unless special filters are installed. (Discussed in section titled "Building preparation before the attack.")
   - Keep all windows and doors shut.
   - Assigned installation personnel should increase air-sampling procedures.
   - The medical staffs in hospitals/clinics are notified of the Bio-Threatcon level to give a heightened awareness of a biological threat and exhibit greater vigilance in disease surveillance.
   - Inside buildings and shelters, personnel must turn on room airflow filter units (Discussed in section titled "Building preparation before the attack.")

3. C (*Charlie*) -

   - All outside personnel on duty must wear lightweight half mask respirators that cover nose and mouth, which can be purchased inexpensively using commercial off the shelf (COTS) technology.
   - Only in an emergency situation should dependents or other personnel exit a building. In that case they should wear their half face respirator.

- Outside personnel are educated to stand with their back to the wind as much as is possible when outside as long as it does not affect completion of the mission.
- Building ventilation systems should be turned off unless special filters are installed. (Discussed in section titled "Building preparation before the attack.")
- Keep all windows and doors shut.
- Assigned installation personnel would increase air-sampling procedures.
- The medical staffs in hospitals/clinics are notified of the Bio-Threatcon level to give a heightened awareness of a biological threat and exhibit greater vigilance in disease surveillance.
- Inside buildings and shelters, personnel must turn on room airflow filter units (Discussed in section titled "Building preparation before the attack.")
- Personnel must have sleeves rolled down.
- Upon detection of BW agents in the area, prophylaxis must begin immediately.

4. D (*Delta*)-

- All outside personnel on duty should wear a full-face military protective mask and hood.
- Only in an emergency situation should dependents or other personnel exit a building. In that case, they should wear their half face respirator.
- Turn off ventilation units unless unbearable temperature demands they run; even then, let operate only if they have a special filter installed. (Discussed in section titled "Building preparation before the attack.")
- Keep all windows and doors shut.
- Assigned installation personnel would increase air-sampling procedures.

- The medical staffs in hospitals/clinics are notified of the Bio-Threatcon level to give a heightened awareness of a biological threat and exhibit greater vigilance in disease surveillance.
- Inside buildings and shelters, personnel must turn on room airflow filter units (Discussed in section titled "Building preparation before the attack.")
- Personnel must have sleeves rolled down.
- Upon detection of BW agents in the area, prophylaxis must begin immediately.

Consequence Management Suggestions

Once a BW attack has occurred, military efforts can be organized to manage the consequences of those attacks. A major aspect of consequence management involves medical treatment with antibiotics, serums, and other appropriate therapies designed to prevent, mitigate, and cure various diseases caused by BW agents. Sufficient medical care personnel will be required to handle casualties, and plans should be made for how to handle mass casualties. Likewise sufficient medications and supplies can be stockpiled in advance in specified locations.

Greater care needs to be taken after a contagious biological weapons attack to prevent further spread of the disease. Quarantine procedures need to be put in place to handle such situations, and police and other security personnel will need to be mobilized to enforce such quarantines. Unfortunately, it is often impossible to know whether a person is infected with a contagious disease until they show symptoms. Therefore, once it appears that a biological weapon has been used, it may be necessary to impose a local quarantine until medical authorities can explicitly rule out the possibility that contagious diseases were not included in the attack.

Note that this may impair the most likely approach to handling mass casualties: moving casualties to other medical facilities. It will often be necessary to solve the mass casualty problem in the area of the initial outbreak until the incubation period has passed for potential contagious diseases (as long as a couple of weeks) or until other actions can be taken to prevent the disease in those not yet symptomatic. This approach will be

a serious problem for the U.S. military, which normally plans to stabilize and then evacuate all casualties. Instead, they may be forced to bring in medical care personnel, supplies, and equipment, and thereby potentially disrupt the force flow into a combat region. By resolving these quarantine, manpower, and supply issues in advance, the "85% Quick Fix" will help enhance protection immediately at other locations.

It may also be necessary to impose some travel restrictions after a biological warfare attack, even when it was clearly not contagious. For example, if a military service member were exposed in Country A, but was transported to Country B and then developed symptoms there, the military may not be able to prove whether this person was exposed in Country A or in Country B, potentially causing hysteria to spread to Country B unnecessarily. All travel should likely be restricted from the area where a BW attack occurred until enough time has passed to definitively diagnose the disease as non-contagious. Note that whether quarantine or travel restrictions are imposed, these will likely disrupt noncombatant evacuation and even conventional casualty evacuation from the area attacked.

With BW attacks, it will not be uncommon for psychological reactions to occur in greater numbers than actual BW/BT casualties. Masses of people, including many with little chance of having been in the infected area, will insist upon receiving medical treatment, potentially exhausting medical supplies in that area. Some will even develop psychosomatic symptoms, making them difficult to differentiate from actual casualties until laboratory work can be accomplished (and thus heightening the laboratory workload.) Many will also try to flee the area of infection, potentially seeking to break quarantine or travel restrictions.

Every effort needs to be made to prevent and then later treat psychological reactions. Efforts to understand the "panic phenomena" and the "worried well" in a BW event should be a priority but often remain under-funded. Aggressive efforts in planning and executing public relations and public information before an attack will probably be one of the commander's most valuable investments to ensure mission completion and prevent chaos. This will usually be best done with an active public information campaign to explain to people what has happened and what they should do about it. The public information

effort can be vastly aided if authorities can accurately determine the time and area of the attack, thereby excluding many people from fear. But the capabilities to do so today are inadequate, and efforts to make such projections may only undermine the effectiveness of the public information as mistakes are made.

Every military facility should have public information packages for various BW agents and various scenarios detailing the types of information that should be released to the public or military forces and when they should be released. The Israeli Home Front Command has had hands on experience with many threats to their population over the last decade. As a result, they have a comprehensive system of communicating with the entire country through television, radio, faxes to key personnel, etc. Additionally, they have prepared thousands of information messages ready to be disseminated depending on the type of event. Their appreciation for minimizing panic and minimizing the numbers of "worried well" has helped them to come up with these valuable mitigation procedures.[29]

Active Defense and Offensive Options

Some BW threats may be best countered using active defenses or offensive options. Active defenses seek to intercept and destroy the means of WMD delivery before they reach the target area. U.S. and allied forces are normally very effective in intercepting opposing aircraft threats, though they would likely be less effective at intercepting ballistic and cruise missiles or terrorists/special forces. Since SOF-delivered BW is perhaps the largest BW threat, active defenses need to be augmented in the form of a more robust security system that is capable of patrolling and monitoring upwind of an installation.

Another way to defeat biological weapons use is to destroy BW through attack operations (counterforce) before the BW can be used. To do so, one must be able to locate the biological weapons storage and production sites and have the proper agent defeat type munitions available to destroy the BW in these sites. As noted earlier, it is difficult at best to locate these sites using current methods. These actions need to be taken before the adversary can disperse its BW agents.

Perhaps one of the strongest defenses against biological weapons use is the ability to inflict unacceptable levels of damage on countries that use

such weapons. Such a retaliatory capability may deter BW attacks if the U.S. leadership possesses both the tools and the will to strike back. Nevertheless, even if he fears capture, a terrorist may not be deterred by retaliatory threats because the terrorist may lack a home location or some other valued item that he would not want damaged by retaliation.

Conclusions

The quest for the "perfect" long-term protection against biological warfare or terrorist attacks must not become the enemy of the "good" solution today. Partial measures can provide significant levels of protection against biological threats at U.S. and allied military bases and facilities.

First, a new Bio-Threat condition alerting system needs to be created, and personnel need to be trained in its use.

Second, each military base must make upgrades to its facilities and acquire commercial off-the-shelf technologies to provide protection to building occupants.

Third, inexpensive masks must be purchased and personnel, including civilians and dependents, should be trained in their use.

In addition, we must deploy biological agent detectors more broadly, enhance disease surveillance systems, enhance stocks of medical supplies needed to treat casualties of biological attacks, design realistic plans to handle mass bio-casualties, develop procedures for quarantine and travel restrictions, and prepare to manage the psychological effects that are expected in the wake of biological weapons attacks.

These are some of the effective quick fixes available to United States now to counter mass casualty bio-events. We need to bolster protection today via the "85% Quick Fix" while working on longer-term, more perfect countermeasures to protect against emerging biological warfare and terrorist threats.

Notes

1. The 85% number here is notional. We believe that a large percentage of potential BW casualties can be averted through a series of quick fixes, but the actual percentage will vary by type of BW and other issues. We cannot say with precision what the actual

improvement will be with detailed scientific studies. Nevertheless, the basis for the 85% number is derived from a scientific understanding of Biological Warfare.

2. David E. Kaplan and Andrew Marshall, *The Cult at the End of the World* (New York: Crown Publishers, 1996), 92, 251, 294.

3. An example of one effort is the U.S. Air Force's *Biological Defense Task Force*, which was a 120-day project in the summer and fall of 2002. This was an effort directed by the Chief of Staff of the USAF through HQ USAF/XONP to assist in developing a concept of operations for military installations in the event it was faced with biological warfare.

4. "Detect to protect" means that a biological attack can be detected before people are infected, giving them time to protect themselves from infection before it arrives.

5. Lt Col Don Noah, USAF, "Medical Intelligence with a Weapon Focus on Biological Warfare." Presentation was at the USAF Counterproliferation Center, Maxwell AFB, on 11 Jan 2000 to an Air War College elective class. He stated that U.S. national threat assessments often uses the formula of: intent + capability + vulnerability = threat. Lt Col Noah was the primary author of the National Medical Intelligence Threat Assessment for the United States, published in January 2000.

6. "Biological weapons can be deployed in three [primary] ways: by contaminating food or water supplies; releasing infected vectors, such as mosquitoes or fleas; or creating an aerosol cloud to be inhaled by the victims. By far, the most effective mode for applying biological weapons [to produce mass casualties] is an aerosol cloud. Such a cloud is made up of microscopic particles and is therefore invisible." Ken Alibek, Testimony to the House Armed Services Committee Oversight Panel on Terrorism, May 23, 2000.

7. *Proliferation of Weapons of Mass Destruction: Assessing the Risks*, U.S. Congress Office of Technology Assessment, August 1993, 53-54.

8. See Steve Fetter, "Ballistic Missiles and Weapons of Mass Destruction," *International Security*, Summer 1991. Computer models like Hazard Predication and Assessment Capability (HPAC) show areas where varying fractions of those present will become anthrax fatalities. Dr. Bruce Bennett did four HPAC runs assuming the use of five kilograms of anthrax, the results of which provide a useful comparison. For an untreated and non-vaccinated population the 90 and 50 percent lethality areas range from 2 to 26 square kilometers (90 percent lethality) and from 31 to 2,600 square kilometers (50 percent lethality). The 20 percent lethality areas run from 500 to 15,000 square kilometers, and the 2 percent fatality areas run from 6,000 to 32,000 square kilometers.

9. Jonathan F. Smith, et. al., "Viral Encephalitides," in *Medical Aspects of Chemical and Biological Warfare*, eds. Frederick R. Sidell, Ernest T. Takafuji, and David R. Franz,

(Washington, D.C.: Office of the Surgeon General, U.S. Army, 1997). (VEE is Venezuelan Equine Encephalitis; EEE is Eastern Equine Encephalitis; and WEE is Western Equine Encephalitis.

10. ECt_{50} is Effect Concentration Time 50%. The ECt_{50} is a measure of the dose at which 50 percent of the population experiences the agent's primary effect. "For a vapour cloud or aerosol presenting a respiratory hazard, the exposure can be conveniently expressed as the product of the agent concentration (C) and the exposure time (t), which is known as the 'Haber Product', or 'Ct' exposure, with units of milligrams minutes per metres cubed (mg.min.m-3). (33) Since the susceptibility to CW agents varies from human to human, it is not possible to specify an exact minimum effective dosage or lethal dose for each agent. As a result, scientists can only define the dosage that has a specified probability of producing a particular effect. It is possible to define the term 'Effect Ct_{50}' (ECt_{50}) which indicates the Ct exposure that has a 50% probability of producing some kind of an effect." Found at British Ministry of Defence site: http://www.mod.uk/issues/gulfwar/info/ukchemical/annexa.htm on 17 January 2003; Also see Brian G. Chow, et. al., *Air Force Operations in a Chemical and Biological Environment*, RAND, DB-189/1-AF. 1998, 29.

11. This table is a modification of the unclassified table at: Brian G. Chow, et. al., *Air Force Operations in a Chemical and Biological Environment*, RAND, DB-189/1-AF. 1998, 29. On-line. Internet, 9 September 2002. Available from http://www.rand.org/publications/DB/DB189.1/DB189.1.pdf/DB189.1.sec2.pdf. Values with a "*" come from USAMRIID, *Medical Management of Biological Casualties Handbook*, February 2001, 64 and Appendices C, D, and I. The vaccine for plague "**" (actually for bubonic as opposed to pneumonic plague) is no longer being produced per Thomas V. Inglesby, et. al., "Plague as a Biological Weapon," *JAMA*, May 3, 2000, 2285.

12. In the aftermath of the anthrax letters, the threshold dose required for some level of anthrax lethality was widely debated. A recent article indicated that even a few spores (about 0.0003 median lethal dose) might cause lethality in a small percent of those exposed, well below the 0.01 levels shown in this chart. See C.J. Peters and D.M. Hartley, "Anthrax Inhalation and Lethal Human Infection," *The Lancet*, February 23, 2002, 710.

13. Dr. Bruce Bennett employed a series of eight HPAC forecasts to estimate these curves; the results showed some variability for other factors, with these curves reflecting roughly median values.

14. For example, 6 of the 11 victims of inhalation anthrax from the 2001 anthrax letters survived based upon antibiotic treatment that started after the development of symptoms. Indeed, in all cases where antibiotic treatment was started during the initial phase of the illness (post-symptoms), the victims survived. See John A. Jernigan, et. al., "Bioterrorism-Related Inhalation Anthrax: The First Ten Cases Reported in the United States," *Emerging Infectious Diseases*, November-December, 2001, 933-944.

15. After potential anthrax exposure, antibiotic use (referred to as prophylaxis) can prevent the disease from developing. See Thomas V. Inglesby, et. al., "Anthrax as a Biological Weapon, 2002," *Journal of the American Medical Association*, May 1, 2002, 2244-2248.

16. See CDC, "Update: Adverse Events Associated with Anthrax Prophylaxis Among Postal Employees – New Jersey, New York City, and the District of Columbia Metropolitan Area, 2001," *Morbidity and Mortality Weekly Report*, November 30, 2001, 1051-1054.

17. Alibek Interview, *Op. cit*.

18. *Joint Vision 2020* is the vision document from the Chairman of the Joint Chief of Staff.

19. "Protection Factor (PF) and Saturation Testing of Commercial Negative Pressure Half-Mask Respirators," Edgewood Chemical & Biological Center (ECBC) Interim Technical Memorandum; Soldier and Biological Chemical Command (AMSSB-REN), Aberdeen Proving Ground, MD, November 9, 2001.

20. "Once the outdoor concentration has diminished to safe levels (as determined by emergency response teams), evacuate the building and flush it with outdoor air. After the contaminated plume passes, the concentration of contamination will actually be higher inside the building than outside, because the building will tend to retain contamination that managed to enter" Phillip N Price, Michael D Sohn, Ashok J Gadgil, et.al., *Protecting Buildings From a Biological or Chemical Attack: actions to take before or during a release., LBNL/PUB-5195.* (Berkeley, California: Lawrence Berkeley National Laboratory, January 10, 2003), 11.

21. Bill Patrick, Biological Warfare Consultant, "The United States Offensive Biological Program (1940-1972)." Presentation was at the USAF Counterproliferation Center, Maxwell AFB, on 19 Feb 1999 to an Air War College elective class.

22. Bill Patrick, Biological Warfare Consultant, "Fundamentals of Biological Warfare." Presentation was for the USAF Counterproliferation Center at USAMRIID, Ft Detrick, Maryland, on 13 Sept 2002 to an Air War College elective class.

23. This can be understood by realizing that only a small portion of each cubic foot of air will have water passing through it during a light or moderate rain or snow. This allows most BW agents to escape being washed to the ground by the water particles passing through it. Bill Patrick, Biological Warfare Consultant, "The United States Offensive Biological Program (1940-1972)." Presentation was at the USAF Counterproliferation Center, Maxwell AFB, on 19 Feb 1999 to an Air War College elective class.

24. Phillip N Price, Michael D Sohn, Ashok J Gadgil, et. al., *Protecting Buildings From a Biological or Chemical Attack: actions to take before or during a release, LBNL/PUB-5195.* (Berkeley, California: Lawrence Berkeley National Laboratory, January 10, 2003), page 30; Centers for Disease Control and Prevention, "Guidance for Protecting Building Environments from Airborne Chemical, Biological, or Radiological Attacks, " May 2002, 19; and on-line, Internet, 10 November 2002, available from http://www.cdc.gov/niosh/bldvent/2002-139.html.

25. There may be some who will complain that BIT, BACE, INFOCON, FPCON and the nation's new homeland security threat levels are all a bit too much for commanders to remember. Yet, the high consequence of an effective BW/BT attack necessitate it receive a separate threat condition from the FPCON. By commingling it with the existing FPCON, this will reinforce in commander's minds that BW/BT is like the chemical threat or other threats. Over time, this will ultimately diminish the commander's understanding of this threat and hence, decrease the proper emphasis that should be placed against this potentially catastrophic and unique danger.

26. The complex nature of command requires commanders to make assessment of risk and deal with those risks while completing the military mission. Dr. Jim Davis developed this table as one concept that could be used to help commanders make simple, yet critically important decisions. A table like this could be applied across the spectrum of all military installations. For instance, an installation in the continental U.S. would hopefully never reach a BIT-2 and would therefore never reach a Bio-Threatcon level of Bravo. Likewise, an installation located in South Korea might frequently be at BIT-2 necessitating its Bio-Threatcon level to change with as climatology (BACE) changes.

27. Two inexpensive respirators were bought randomly from a local hardware to show the accessibility of protective gear. Mine Safety Appliances (MSA) Company had two respirators priced reasonably: *Dust Respirator with odor filter for Harmful Dust* ($4.93) and *Dust Respirator with exhalation valve for Harmful Dust* ($6.97). Both respirators were rated N95. According to a manufacturer representative this means the filters in these masks can filter 95% of the particles down to 0.3 microns. The main concern for human infectivity of BW/BT agents is the 1 to 10 micron range.

28. Bill Patrick related through personal anecdotal experience that by having his back to the wind with even crude respiratory protection reduced the concentration of deposited BW agent simulate around his face. Bill Patrick, Biological Warfare Consultant, "Fundamentals of Biological Warfare." Presentation was for the USAF Counterproliferation Center at USAMRIID, Ft Detrick, Maryland, on 13 Sept 2002 to an Air War College elective class.

29. Col Gilad Shenhar, Head of Doctrine & Development Dept., Israeli Defense Force Home Front Command, "Home Front Command Overview with Emphasis on Chemical and Biological Warfare Issues. " Presentation was given at Home Front

Command Headquarters, Israel on 30 Oct 2002 to a delegation of USAF officers (one of the authors was part of the delegation) supporting the Office of the Secretary of Defense's Bilateral Counterproliferation Working Group.